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(54) **Ultraviolet spatial sensor**

Ultraviolett Sensor mit Ortsäuflösung

Capteur ultraviolet à résolution spatiale

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Description

The invention relates to an ultraviolet spatial sensor and more particularly to a wide-field-of-view photon counting sensor using a microchannel plate and a discrete anode array.

BACKGROUND OF THE INVENTION

Prior art devices based on charge centroiding techniques such as the resistive anode and wedge strip anode, provide good resolution but suffer from coincidence losses. During periods of intense radiation they generate spurious signals spatially located between two actual photo events. This occurs when their centroiding electronics cannot temporarily resolve multiple photo events. These losses manifest themselves in either false targets or loss of signal and therefore lead to false target detections or decreasing sensitivity of the detector. This behavior may undermine the performance of an application utilizing this type of sensor. The present invention seeks to avoid this behavior since centroiding of individual photo events is not necessary.

United States Patent 4,395,636 to Hal O. Anger, et al., entitled "Radiation Imaging Apparatus," describes a radiation imaging system using a charge multiplier and a position sensitive anode for detecting the centroid position of a charge cloud. The apparatus has two dimensional position coordinate readout capability. The apparatus images incident photons, ions, electrons, or nuclear particles, and has a high inherent spatial and linear resolution. The apparatus disclosed includes systems which use the fast response of microchannel plates, position sensitive repetitive strip and wedge region anodes, and preamps to perform scintillation pulse height analysis digitally.

United States Patent 4,845,552 to Bruno Jaggi, et al., entitled "Quantitative Light Microscope Using a Solid State Detector in the Primary Image Plane," describes a solid state microscope apparatus for viewing and scanning microscopic objects. The microscope comprises a light source with a condenser and diffusion filter. The image is projected directly, through one high resolution lens (an objective), onto a large two-dimensional CCD-array or similar solid state image sensor located in the intermediate plane of the objective lens. The sensed discrete image is digitized, conditioned and processed in real time and displayed on a high resolution monitor.

United States Patent 4,872,051 to Robert H. Dye, entitled "Collision Avoidance Alarm System," describes an apparatus for detecting the presence of any object on a collision course with a platform or vehicle carrying the apparatus and for generating an alarm upon such detection. A wide-angle television system is used for viewing a scene and providing a plurality of electrical signals corresponding to, and representing the spatial distribution of radiation emanating from the scene. The optical sensor used is optionally of a visible, infrared, or ultraviolet type. Consecutive spatial centroids of an object are computed and used in conjunction with an object's extent to establish possibility of collision.

United States Patent 5,131,742 to Fred L. Schaff, entitled "Acousto-Optic Spectrometer/Polarimeter," describes a device which allows broad-band imaging, spectroscopy and polarimetry to be performed simultaneously, and through the same optical aperture. The device comprises an acousto-optic spectrometer/polarimeter for analyzing an incident broad-band beam including an acousto-optic tunable filter for separating the incident broad-band beam into a diffracted extraordinary narrow-band beam, a diffracted ordinary narrow-band beam, and at least one undiffracted broad-band beam. The device further comprises three detectors, each respectively positioned to receive at least a portion of the respective beams and provide first, second, and third signals thereon. Means are provided for radio frequency control, and for transducing an acoustic wave in the acousto-optic tunable filter.

IEEE Transactions on Nuclear Science, Vol. NS-29, No.1; W G Sandie *et al:* "Characteristics of a microchannel plate intensifier" and Optical Engineering, Vol.22, No.6; W G Sandie *et al:* "Atmospheric emissions photometric imaging experiment for Spacelab 1" describe a detector system having a wide-angle/telephoto low-light level TV system in conjunction with a complementary telephoto photon counting array. Rev. Sci. Instrum., Vol. 46, No. 12; J G Timothy *et al:* "Two dimensional photon-counting detector arrays based on microchannel array plates" describes the use of microchannel array plates in photon-counting detector arrays.

SUMMARY OF THE INVENTION

The invention provides a wide field of view photon counting sensor for detecting radiation sources of a predetermined frequency range, according to Claim 1. The sensor comprises an integrated filter-optic element which provides an image signal from a scene of interest to a spatial detector. According to one aspect, the detector is comprised of a photo cathode, an electron multiplying microchannel plate and a discrete anode array. The microchannel plate and array combine to preserve the spatial distribution of the image. The sensor uses counting electronics to measure a signal that is proportional to the detected radiation source.

In one preferred embodiment of the invention, the counting electronics are connected to a serial interface which provides each anode signal to a computer processor. In one embodiment of the invention, the detector allows the determination of an ultraviolet source to within plus or minus 4.5 degrees.

In yet embodiment of the invention, the integrated filter-optic means detects images in the middle ultraviolet range while rejecting radiation outside the middle ultraviolet range.

Other objects, features and advantages of the present invention will become apparent to those skilled in the art through the description of the preferred embodiment, claims and drawings herein wherein like numerals refer to like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

To illustrate this invention, a preferred embodiment will be described herein with reference to the accompanying drawings.

Figure 1 shows a schematic diagram of the ultraviolet spatial sensor of the invention.

Figure 2 shows a multi-anode microchannel plate photomultiplier used in an ultraviolet spatial sensor of the invention.

Figure 3 shows the 10x10 discrete anode array used in the ultraviolet spatial sensor of the invention.

Figure 4 shows a sensor electronics block diagram used in the ultraviolet spatial sensor of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 shows a schematic diagram of the ultraviolet spatial sensor of the invention. Incident radiation 24 is received through an integrated filter-optic system 10. The integrated filter-optic system 10 is comprised of a lens 26 and a filter 28, such as an ultraviolet filter. The integrated filter-optic system 10 provides an image to an ultraviolet spatial detector 12. The ultraviolet spatial detector 12 is comprised of a 100 pixel discrete anode array using a high strip current microchannel plate position sensitive detector. In one preferred embodiment of the invention, the integrated filter-optic system 10 provides a wide field of view integrated filter-optic assembly which provides a compact system with a low f/#.

The ultraviolet spatial detector 12 is powered by a high voltage power supply 20. The ultraviolet spatial detector 12 provides counting electronics 18 with the signal proportional to the incident radiation 24 from the scene of interest. The counting electronics are optionally sent to a computer processor 22 through serial interface 16, or may be provided directly to the computer processor 22.

Figure 2 shows a multi-anode microchannel plate photomultiplier used in the ultraviolet spatial detector 12 of the invention. An optical window 30 is in contact with photocathode 32. The window views a scene of interest. In one preferred embodiment of the invention the photocathode 32 may be a 40mm active diameter photocathode. The photocathode 32 responds to ultraviolet radiation and rejects longer wavelengths when mated with a filter. In one embodiment, the photocathode 32 is of the RbCsTe variety. A stack of three microchannel plate electron multipliers 34, 36, and 38 in a Z configuration are used to amplify the electron signal from the photocathode 32. The microchannel plate electron multipliers provide an internal gain mechanism for generating electrons in response to output of the photocathode 32. The microchannel plate Z stack 39 is comprised of an array of channel electron multipliers fused into a single element. Such microchannel plates are known and are commercially available. However, those skilled in the art will recognize that such microchannel plates are not to be confused with devices such as conventional dynode electron multipliers which do not preserve spatial relationships. The microchannel plate 39 preserves the spatial distribution of the irradiance pattern at the photocathode 32 during the multiplication process.

Those skilled in the art will also recognize that any electron gain medium that preserves the spatial distribution of the electron signal will accomplish a similar result.

A multi-element discrete anode array, comprising a plurality of anodes which are regularly spaced in a grid pattern, follows in the signal path after the microchannel plate 39. In one preferred embodiment of the invention there are 100 discrete anodes arranged in an array of 10x10 metal pads. The discrete anode array 40 is used for charge collection.

Referring simultaneously now to Figure 2 and Figure 3, Figure 3 shows the 10x10 discrete anode array with square pixels. Each of the pixels, shown as, for example, 42, 44, 46, 48 and 50, are equal in size. The discrete anode array is configured to preserve the spatial distribution of the irradiance pattern. The discrete anode array is interfaced to counting electronics via a 100-element pin grid array 41. The sensor created from this configuration is a passive uncooled sensor with no moving parts. The sensor is a continuous staring device producing an uninterrupted spatio-temporal signature of absorbed targets.

Because the sensor employs photon counting it is able to detect extremely low irradiance levels. In the photon counting sensor, the detector converts photo events into current pulses. These current pulses are then sensed by the processing electronics shown in more detail in Figure 4. The electronics integrate the number of pulses arriving over a fixed integration time interval. The total count observed during that interval is directly proportional to the number of photons which arrived during that interval and hence is a measure of the incident radiation. Since the sensor preserves the spatial distribution of the irradiance pattern, it also provides a spatial measurement of the incident radiation on a pixel by pixel basis. This form of irradiance measurement is more sensitive than simply measuring the average output current from the detector because individual photo events (i.e. individual photons) are discerned.

Those skilled in the art will appreciate that the window 30 may be comprised of a filter-optic combination having lenses and filtering functions combined into a single sub-assembly. Those skilled in the art will also recognize that the filter-optic may cover a wide conical field of view.

Refer now to Figure 4, Figure 4 shows the signal processing electronics in block diagram form employed in the ultraviolet spatial sensor of the invention. The discrete anode array 40 is shown driving an amplifier circuit 70. For simplicity only two of the amplifier circuits are shown. In one preferred embodiment there would be one amplifier circuit for each discrete anode in the discrete anode array 40. The pre-amplifier 52 accepts the signal from the discrete anode pixel 42. The signal is amplified and fed to comparator 56 which compares a signal to a predefined threshold. The output of the comparator 56 is sent to an eight-bit counter to count the photo events from the anode 42. The eight-bit counter 60 is fed to an eight-bit latch 64 so that its value may be read using serial interface electronics 16.

In one preferred embodiment of the invention the readout electronics comprise a serial interface which is sent to a central processing unit 22. Likewise the other discrete anodes are read using similar circuitry. For example, the readout electronics 72 for anode 50 has a similar pre-amplifier 54. The amplifier 54 is connected to a comparator 58 which connects to an eight-bit counter 62 and an eight-bit latch 66. The serial interface 16 is provided to minimize the number of interconnections to the central processor 22. Those skilled in the art will recognize that other addressing schemes will work with the invention.

Those skilled in the art will also recognize that the comparator 58 serves to reject low amplitude noise pulses originating in the detector. It also acts as a one-bit analog to digital converter to prepare the incoming pulses for digital counting. The eight-bit counter 60 integrates all pulses during a sample period. The latch 64 stores the resulting total count. The counter 60 is then free to reset and begin accumulating the next frame of data. The latch 64 stores a frame of data for transfer along the serial interface 16 for communication to the CPU 22. In one example of the invention, the count output is provided at a rate of at least a four kilohertz frame rate.

Those skilled in the art will recognize that the electronics may be embodied in surface mounted electronics within a spatial sensor.

In operation the discrete anode array provides a level of resolution that may be designed to meet predefined objectives. The number of discrete anodes may be varied to provide a predetermined resolution. Other anode configurations are also possible because the microchannel plate preserves the spatial distribution of the radiation pattern.

The invention has been described herein in considerable detail in order to comply with the Patent convention and to provide those skilled in the art with the information needed to apply the novel principles and to construct and use such specialized components as are required. However, it is to be understood that the invention can be carried out by specifically different equipment and devices, and that various modifications, both as to the equipment details and operating procedures, can be accomplished without departing from the scope of the invention as defined in the claims.

Claims

1. A spatial sensor apparatus comprising :

   (a) a filter-optic means (10) for projecting a view of a scene in a predetermined frequency range having a scene output ; and

   (b) a photon counting spatial detector means (12,18) for detecting photons of the predetermined frequency range and conserving their spatial position, wherein the photon counting spatial detector means (12,18) is coupled to the scene output and has an image output;

   characterized in that

   (c) the filter-optic means (10) is an integrated filter-optic means (10) comprised of a wide field of view lens (26) integrated with an ultraviolet filter (28).

2. The spatial sensor apparatus of Claim 1 further comprising a counting means (18) for counting photons coupled to the image output having a count output proportional to a number of incident photons (24) at predetermined positions.

3. The spatial sensor apparatus of Claim 1 wherein the photon counting spatial detector means (12) comprises an anode array (40) having at least 100 pixel anodes (42,44,46,48,50) and a microchannel electron multiplying plate (39) coupled to the anode array (40).

4. The spatial sensor apparatus of Claim 2 wherein the count output is interfaced to a computer processor (22).

5. The spatial sensor apparatus of Claim 2 wherein the count output is provided to a computer processor (22) through a serial interface (16).

6. The spatial sensor apparatus of Claim 2 wherein the count output is provided at a rate of at least a four kilohertz frame rate.

7. The spatial sensor apparatus of Claim 1 wherein the photon counting spatial detector (12) means provides a continuous staring operation with no more than 250 nanoseconds of dead time between frames.

8. The spatial sensor apparatus of Claim 1 wherein the

integrated filter-optic means (10) detects images in the middle ultraviolet range while rejecting radiation outside the middle ultraviolet range.

9. The spatial sensor apparatus of Claim 1, wherein said photon counting spatial detector means comprises:

   (a) an imaging means (12) for capturing radiation (24) having an electron output, the imaging means being positioned to receive radiation transmitted through the integrated filter optic means (10);
   (b) a spatial distribution preserving electron multiplying means (39) having an electron input coupled to the electron output and wherein the spatial distribution preserving electron multiplying means (39) also has a gain electron output; and
   (c) a means for spatially sensing an electron distribution (40) having a spatial distribution input coupled to the gain electron output.

10. The spatial sensor apparatus of Claim 9 wherein the imaging means (12) further comprises a lens (30) and a photocathode (32).

11. The spatial sensor apparatus of Claim 9 wherein the spatial distribution preserving electron multiplying means (39) comprises a microchannel plate Z stack (39).

12. The spatial sensor apparatus of Claim 9 wherein the means for spatially sensing (40) comprises a discrete anode array (40).

13. The spatial sensor apparatus of Claim 9 wherein the means for spatially sensing (40) comprises a discrete anode array (40) comprising a plurality of anodes (42,44,46,48,50) which are regularly spaced in a grid pattern.

14. The spatial sensor apparatus of Claim 12 wherein the discrete anode array (40) is arranged in a pattern to match the imaging means (12).

15. The spatial sensor apparatus of Claim 10 where the photocathode (32) is comprised of RbCsTe.

16. The spatial sensor apparatus of Claim 9 wherein the radiation (24) is in the ultraviolet range.

17. The spatial sensor apparatus of Claim 13 further including, for each of said plurality of anodes:

   (a) preamplifier means (52), with an anode input coupled to a respective one of said plurality of anodes, wherein the preamplifier means (52) has an amplified signal output;
   (b) comparator means (56) having an input coupled to the amplified signal output having a threshold output;
   (c) counter means (60) for receiving the threshold output wherein the counter means (60) has a count output which carries a count;
   (d) a memory means (64) for storing the count coupled to the count output.

18. The spatial sensor apparatus of Claim 17 wherein the counter means (62) comprises at least an 8 bit counter (62) and the memory means (64) comprises at least an 8 bit latch (64).

19. The spatial sensor apparatus of Claim 17 wherein the comparator means (56) further comprises an analog to digital converter.

Patentansprüche

1. Räumlich auflösende Sensorvorrichtung mit:

   (a) einem filteroptischen Mittel (10) zum Projizieren einer Ansicht einer Szene in einem vorgegebenen Frequenzbereich, das eine Szenenausgabe aufweist, und
   (b) einem photonenzählenden räumlich auflösenden Detektormittel (12, 18) zum Detektieren von Photonen des vorgegebenen Frequenzbereichs und zum Konservieren ihrer räumlichen Position, wobei das photonenzählende Detektormittel (12, 18) an die Szenenausgabe angeschlossen ist und eine Bildausgabe aufweist,

   dadurch gekennzeichnet, daß

   (c) das filteroptische Mittel (10) ein integriertes filteroptisches Mittel ist, das von einer mit einem Ultraviolettfilter zusammengefaßten Weitwinkellinse (26) ausgebildet wird.

2. Räumlich auflösende Sensorvorrichtung nach Anspruch 1, die weiterhin ein Zählmittel (18) zum Zählen von Photonen aufweist, das an die Bildausgabe angeschlossen ist und das eine Zahlausgabe aufweist, welche einer Anzahl von in vorgegebene Positionen einfallenden Photonen (24) proportional ist.

3. Räumlich auflösende Sensorvorrichtung nach Anspruch 1, wobei die photonenzählenden Detektormittel (12) ein Anodenfeld (40) mit mindestens 100 Pixelanoden (42, 44, 46, 48, 50) und eine an das Anodenfeld (40) angeschlossene Mikrokanalelektronenvervielfacherplatte (39) aufweisen.

4. Räumlich auflösende Sensorvorrichtung nach Anspruch 2, wobei die Zahlausgabe an einen Rechnerprozessor angepaßt ist.

5. Räumlich auflösende Sensorvorrichtung nach Anspruch 2, wobei die Zahlausgabe einem Rechnerprozessor (22) über eine serielle Schnittstelle (16) bereitgestellt wird.

6. Räumlich auflösende Sensorvorrichtung nach Anspruch 2, wobei die Zahlausgabe mit der Rate einer Bildfrequenz von mindestens vier Kilohertz bereitgestellt wird.

7. Räumlich auflösende Sensorvorrichtung nach Anspruch 1, wobei die photonenzählenden räumlich auflösenden Detektormittel (12) einen kontinulierlichen Anzeigebetrieb vorsehen, mit nicht mehr als 250 Nanosekunden Totzeit zwischen den Bildern.

8. Räumlich auflösende Sensorvorrichtung nach Anspruch 1, wobei das integrierte filteroptische Mittel (10) Bilder in dem mittleren Ultraviolettbereich detektiert, während es Strahlung außerhalb des mittleren Ultraviolettbereichs verwirft.

9. Räumlich auflösende Sensorvorrichtung nach Anspruch 1, wobei das photonenzählende räumlich auflösende Detektormittel aufweist:

(a) ein abbildendes Mittel (12) zum Aufnehmen von Strahlung (24), das einen Elektronenausgang aufweist, wobei das abbildende Mittel angeordnet ist, um Strahlung, die durch das integrierte filteroptische Mittel (10) transmittiert wurde, zu empfangen,
(b) ein eine räumliche Verteilung bewahrendes elektronenvervielfachendes Mittel (39) mit einem Elektroneneingang, der an die Elektronenausgabe angeschlossen ist, wobei das eine räumliche Verteilung bewahrende elektronenvervielfachende Mittel (39) auch einen Elektronenverstärkerausgang aufweist, und
(c) ein Mittel zum räumlichen Erfassen einer Elektronenverteilung (40) mit einem Eingang für die räumliche Verteilung, der an den Elektronenverstärkerausgang angeschlossen ist.

10. Räumlich auflösende Sensorvorrichtung nach Anspruch 1, wobei das Abbildungsmittel (12) weiterhin eine Linse (30) und eine Photokatode (32) aufweist.

11. Räumlich auflösende Sensorvorrichtung nach Anspruch 9, wobei das eine räumliche Verteilung bewahrende elektronenvervielfachende Mittel (39) einen Mikrokanalplatten-Z-Stapel (39) aufweist.

12. Räumlich auslösende Sensorvorrichtung nach Anspruch 9, wobei das Mittel (40) zum räumlichen Erfassen ein diskretes Anodenfeld (40) aufweist.

13. Räumlich auflösende Sensorvorrichtung nach Anspruch 9, wobei das Mittel (40) zum räumlichen Erfassen ein diskretes Anodenfeld (40) aufweist, das eine Mehrzahl von Anoden (42, 44, 46, 48, 50) aufweist, welche in einem Gittermuster regelmäßig beabstandet sind.

14. Räumlich auflösende Sensorvorrichtung nach Anspruch 12, wobei das diskrete Anodenfeld (40) in einem Muster angeordnet ist, das zu dem Abbildungsmittel (12) paßt.

15. Räumlich auflösende Sensorvorrichtung nach Anspruch 10, wobei die Photokatode (32) aus RbCsTe ausgebildet ist.

16. Räumlich auflösende Sensorvorrichtung nach Anspruch 9, wobei die Strahlung (24) im ultravioletten Bereich liegt.

17. Räumlich auflösende Sensorvorrichtung nach Anspruch 13, die weiterhin für jede der Mehrzahl von Anoden aufweist:

(a) ein Vorverstärkermittel (52) mit einem Anodeneingang, der an jeweils eine der Mehrzahl von Anoden angeschlossen ist, wobei das Vorverstärkermittel (52) eine verstärkte Signalausgabe aufweist,
(b) ein Komparatormittel (56) mit einem Eingang, der an die verstärkte Signalausgabe angeschlossen ist und eine Schwellwertausgabe aufweist,
(c) ein Zählermittel (60) zum Empfangen der Schwellwertausgabe, wobei das Zählermittel (60) eine Zahlausgabe aufweist, an der eine Zahl anliegt,
(d) ein Speichermittel (64) zum Speichern der Zahl, die an der Zahlausgabe angelegt ist.

18. Räumlich auflösende Sensorvorrichtung nach Anspruch 17, wobei das Zählermittel (62) mindestens einen 8-bit-Zähler (62) und das Speichermittel (64) mindestens einen 8-bit-Flipflop (64) aufweist.

19. Räumlich auflösende Sensorvorrichtung nach Anspruch 17, wobei das Komparatormittel (56) weiterhin einen Analog/Digitalwandler aufweist.

Revendications

1. Dispositif capteur spatial comprenant :

(a) des moyens formant filtre et optique (10),

pour projeter une vue d'une scène dans une plage de fréquences prédéterminée comportant une sortie de scène ; et

(b) des moyens formant détecteur spatial de comptage de photons (12, 18), pour détecter des photons de la plage de fréquences prédéterminée et conserver leur position spatiale, où les moyens formant détecteur spatial de comptage de photons (12, 18) sont couplés à la sortie de scène et comportent une sortie d'image ;

caractérisé en ce que

(c) les moyens formant filtre et optique (10) sont des moyens formant filtre et optique intégrés (10) comprenant une lentille à large champ de vision (26) intégrée avec un filtre ultraviolet (28).

2. Dispositif capteur spatial selon la revendication 1, comprenant en outre des moyens de comptage (18) pour compter les photons couplés à la sortie d'image, ayant une sortie de compte proportionnelle au nombre de photons incidents (24) à des positions prédéterminées.

3. Dispositif capteur spatial selon la revendication 1, dans lequel les moyens formant détecteur spatial de comptage de photons (12) comprennent une matrice d'anodes (40) ayant au moins 100 anodes de pixels (42, 44, 46, 48, 50) et une plaque de multiplication d'électrons à micro-canaux (39) couplée à la matrice d'anodes (40).

4. Dispositif capteur spatial selon la revendication 2, dans lequel la sortie de compte est interfacée avec un processeur d'ordinateur (22).

5. Dispositif capteur spatial selon la revendication 2, dans lequel la sortie de compte est fournie à un processeur d'ordinateur (22) par l'intermédiaire d'une interface en série (16).

6. Dispositif capteur spatial selon la revendication 2, dans lequel la sortie de compte est fournie à un débit d'une cadence d'images d'au moins quatre kilohertz.

7. Dispositif capteur spatial selon la revendication 1, dans lequel les moyens formant détecteur spatial de comptage de photons (12) fournissent un fonctionnement d'observation continue avec un temps mort entre images qui n'est pas supérieur à 250 nanosecondes.

8. Dispositif capteur spatial selon la revendication 1, dans lequel les moyens formant filtre et optique intégrés (10) détectent des images dans la plage des ultraviolets moyens, tout en rejetant le rayonnement situé à l'extérieur de la plage des ultraviolets moyens.

9. Dispositif capteur spatial selon la revendication 1, dans lequel lesdits moyens formant détecteur spatial de comptage de photons comprennent :

(a) des moyens de formation d'image (12) pour capturer un rayonnement (24) comportant une sortie d'électrons, les moyens de formation d'image étant positionnés pour recevoir le rayonnement transmis à travers les moyens formant filtre et optique intégrés (10) ;

(b) des moyens de multiplication d'électrons conservant la répartition spatiale (39) comportant une entrée d'électrons couplée à la sortie d'électrons et où les moyens de multiplication d'électrons conservant la répartition spatiale (39) comportent également une sortie d'électrons à gain ; et

(c) des moyens pour détecter spatialement une répartition d'électrons (40), comportant une entrée de répartition spatiale couplée à la sortie d'électrons à gain.

10. Dispositif capteur spatial selon la revendication 9, dans lequel les moyens de formation d'image (12) comprennent en outre une lentille (30) et une photocathode (32).

11. Dispositif capteur spatial selon la revendication 9, dans lequel les moyens de multiplication d'électrons conservant la répartition spatiale (39) comprennent une pile en Z de plaques à micro-canaux (39).

12. Dispositif capteur spatial selon la revendication 9, dans lequel les moyens pour détecter spatialement (40) comprennent une matrice d'anodes discrètes (40).

13. Dispositif capteur spatial selon la revendication 9, dans lequel les moyens pour détecter spatialement (40) comprennent une matrice d'anodes discrètes (40), comprenant une pluralité d'anodes (42, 44, 46, 48, 50) qui sont régulièrement espacées selon un motif en grille.

14. Dispositif capteur spatial selon la revendication 12, dans lequel la matrice d'anodes discrètes (40) est agencée selon un motif pour s'adapter aux moyens de formation d'image (12).

15. Dispositif capteur spatial selon la revendication 10, où la photocathode (32) est composée de RbCsTe.

16. Dispositif capteur spatial selon la revendication 9,

dans lequel le rayonnement (24) est dans la plage des ultraviolets.

17. Dispositif capteur spatial selon la revendication 13, comprenant en outre, pour chacune de ladite pluralité d'anodes :

(a) des moyens formant préamplificateur (52), avec une entrée d'anode couplée à une anode respective de ladite pluralité d'anodes, où les moyens formant préamplificateur (52) ont une sortie de signal amplifié ;
(b) des moyens formant comparateur (56), ayant une entrée couplée à la sortie de signal amplifié ayant une sortie à seuil ;
(c) des moyens formant compteur (60), pour recevoir la sortie à seuil, où les moyens formant compteur (60) ont une sortie de compte qui comporte un compte ;
(d) des moyens de mémoire (64) pour stocker le compte couplé à la sortie de compte.

18. Dispositif capteur spatial selon la revendication 17, dans lequel les moyens formant compteur (62) comprennent au moins un compteur de 8 bits (62) et les moyens de mémoire (64) comprennent au moins un verrou de 8 bits (64).

19. Dispositif capteur spatial selon la revendication 17, dans lequel les moyens formant comparateur (56) comprennent en outre un convertisseur analogique-numérique.

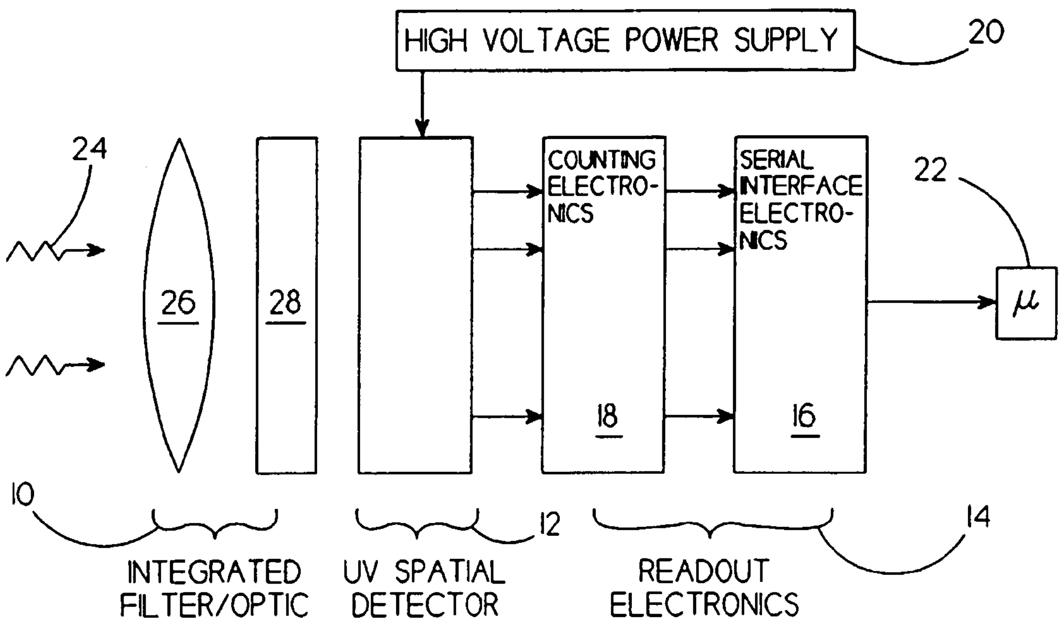
HIGH VOLTAGE POWER SUPPLY
20
24
26
28
COUNTING ELECTRONICS
18
SERIAL INTERFACE ELECTRONICS
16
22
μ
10
12
14
INTEGRATED FILTER/OPTIC
UV SPATIAL DETECTOR
READOUT ELECTRONICS

Fig. 1

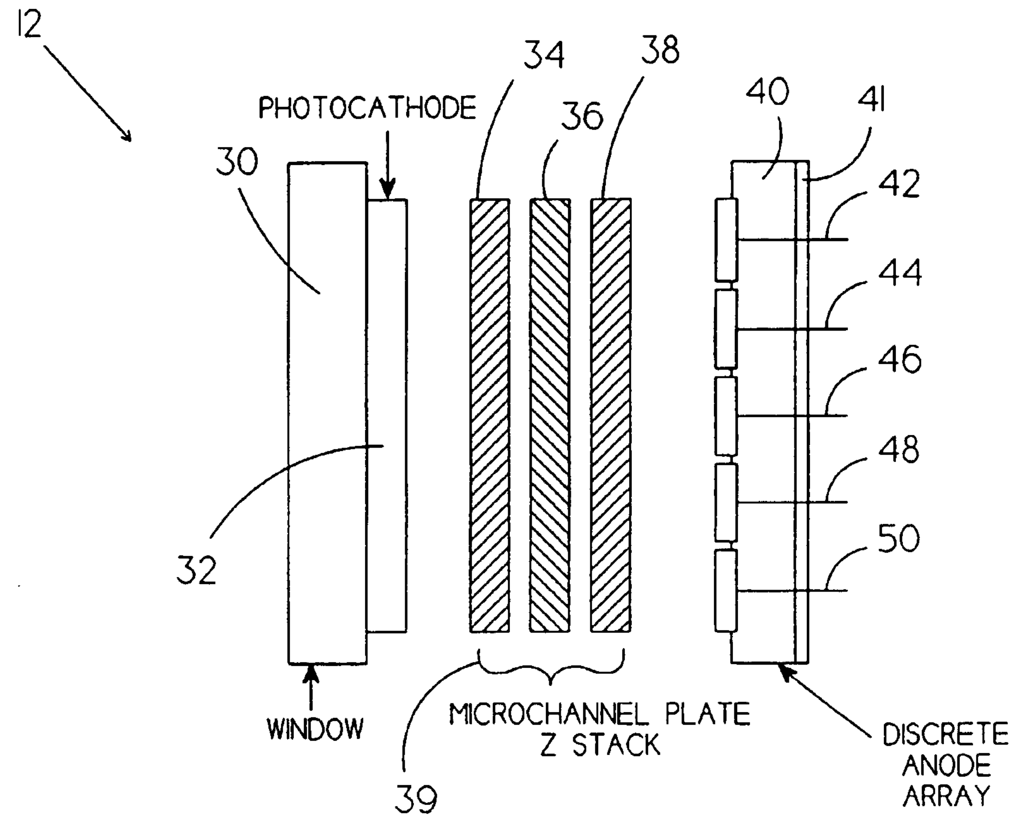
12
PHOTOCATHODE
34
36
38
40
41
30
42
44
46
48
50
32
WINDOW
MICROCHANNEL PLATE
Z STACK
39
DISCRETE
ANODE
ARRAY

Fig_2

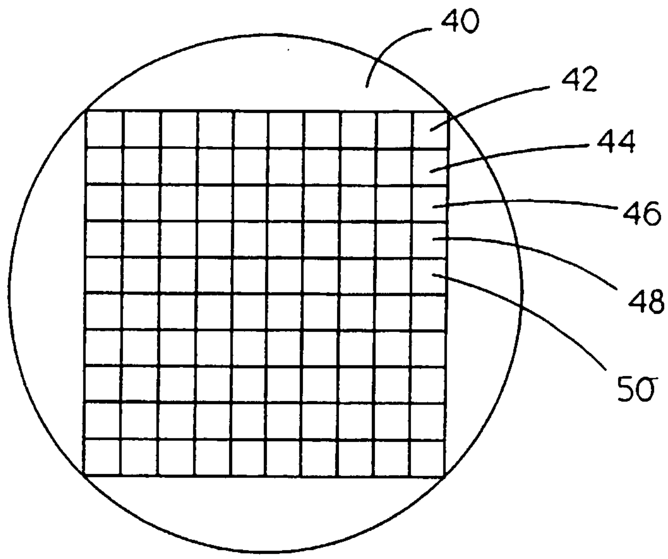

Fig. 3

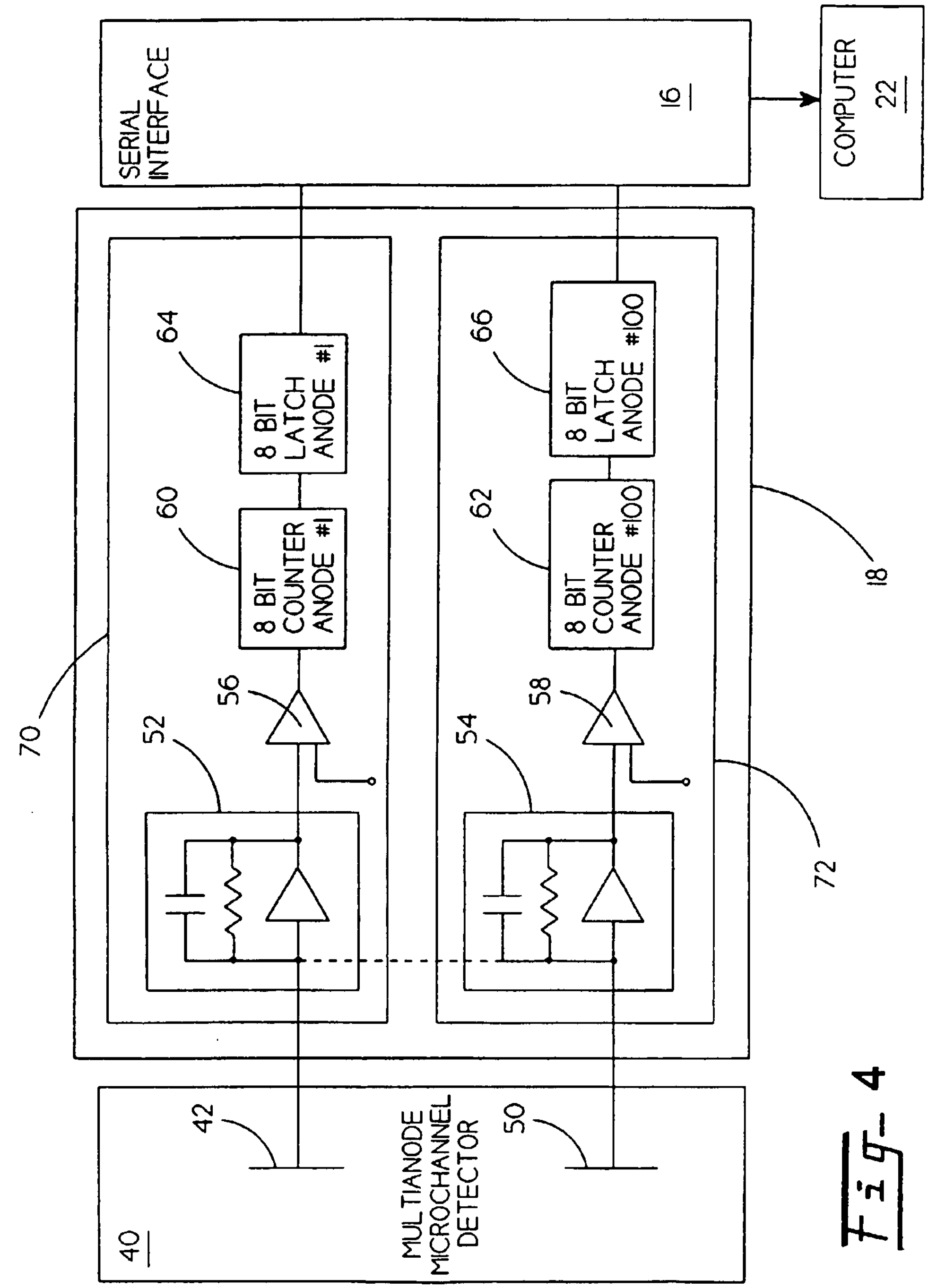
SERIAL INTERFACE
16
COMPUTER
22
8 BIT LATCH ANODE #1
8 BIT COUNTER ANODE #1
8 BIT LATCH ANODE #100
8 BIT COUNTER ANODE #100
64
60
66
62
56
52
58
54
70
72
18
42
50
40
MULTIANODE MICROCHANNEL DETECTOR

Fig. 4